ISSN: 0975-3583,0976-2833 VOL14, ISSUE 08, 2023

OCULAR BIOMETRY IN DIFFERENT STAGES OFPRIMARY ANGLE CLOSURE GLAUCOMA

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ABSTRACT
Background: Primary angle-closure glaucoma is one of the significant causes of blindness worldwide. It is a disease related to ocular anatomy that is related to pupillary-block and angle-crowding. Eyes prone to primary angle-closure are small with decreased AXL, ACD, and filtration angle width, associated with a proportionately large lens. As the age progresses, there is a decrease in anterior chamber depth because ofincreasing lens thickness.
Aim: The purpose of this study is to compare the differences in Ocular Biometric measurements among different stages of PACG, including 1) Primary angle-closure suspect, 2) Primary angle closure, and 3) Primary angle-closure glaucoma.
Methodology: A study titled "Ocular Biometry in Different Stages of Primary Angle Closure Glaucoma" was undertaken at the regional eye hospital, Kurnool, from November 2018 to October 2020. In the present study, 111 eyes were included after fulfilling the inclusion criteria.
Results: In the total of 111 eyes, 29 eyes of open angles(control group),40 eyes of PACS,12 eyes of PAC, and 30 eyes with PACG with a clear lens were subjected to ocular Biometric parameters like ACD, LT, AXL, LAF, RLP, CD, Mean keratometry. After completing the study, the results were analyzed. In the PACS group - The mean axial length was 22.17±0.27, Mean LT was 4.54±0.25, Mean ACD was 2.38±0.15, mean LAF was 2.04±0.11, Mean RLP was 2.1±0.07, Mean CD was 11.25±0.06, Mean keratometry was 45.63±0.19. In PAC Group - Mean axial length was 22.34+0.11, Mean LT was 4.38±0.16, Mean ACD was 2.38±0.14, mean LAF was 1.96±0.07, Mean RLP was 2.05±0.08 Mean CD was 11.4±0.05, Mean keratometry was 45.38±0.38. This study revealed a thicker lens($p=0.001$) and showed a significantly anteriorly placed lens($p<0.001$) compared to the controls and thus is an essential contributing factor in producing a shallower chamber. The AXL in the present study was considerably less in PACS and lesser in PACG in the eyes. The lens was detected to be anteriorly placed ($p<0.001$) in PACG, PAC, and PACS compared to open angles. The corneal diameter($p<0.001$) is shorter in PACG, PAC, and PACS compared control group. The Corneal Curvature (Mean Keratometry) ($P=0.001$) is steeper in PACG, PAC, and PACS than open angles.
Conclusion: In this study, PACS eyes were associated with short axial length, shallow anterior chamber, thick crystalline lens, anteriorly placed lens, small corneal diameter, and steep corneal curvature than the eyes of the open-angle group. PAC eyes were associated with shallow anterior chambers, thick crystalline lens, anteriorly placed lens, small corneal diameter, steep corneal curvature compared to the open-angle group.

Keywords: PACS, PACG, Keratometry, Glaucoma, Biometric Parameters

INTRODUCTION

Glaucoma is a chronic progressive multifactorial optic neuropathy caused by a group of ocular disorders that damage the optic nerve with a resultant loss of visual function. The main risk factor is the raised intraocular pressure.[1]

Glaucoma ranks the second leading cause of blindness globally and an Irreversible cause of Blindness. Angle-closure Glaucoma is regarded as the leading cause of irreversible blindness worldwide, and the incidence of primary angle-closureglaucoma is higher in Asians.[2]

About 15 million people worldwide have been affected by the angle-closure disease in 2010, this number expected to increase to 21 million by 2020[3]. Tham *et al*. estimated that the number of people affected with PACG worldwide would be 23.36 million and 32.04 million in 2020 and 2040, respectively. Similarly, in Asians, it would be 17.96 million and 24.5 million, respectively [4].

In India, primary angle-closure glaucoma comprises approximately 50% of Primary glaucoma and is the leading cause of blindness. Appropriate identification and early management can prevent long-term morbidity from this disease [5]. The high rate of blindness in the Indian population is due to a high proportion of undiagnosed glaucoma in the community.

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Therefore early detection is essential.

Known risk factors for primary angle-closure glaucoma include Biometric Parameters like a shallow anterior chamber, thick Lens, anterior lens disposition, small corneal diameter, the shorter axial length of the globe, and a small radius of corneal curvature[6]. As the age progresses, the change in ocular dimensions like increasing lens thickness leads to shallow anterior chamber results in narrow angles. Ocular Biometry includes measuring various eye dimensions like Axial length, Anterior chamber depth, lens thickness, Corneal curvature, and Corneal diameter.

Different instruments available to measure these parameters are A-Scan ultrasonography, keratometer, Optical biometers like IOL Master and LENSTAR, Orbscan, and Pentacam.

A-scan ultrasonography is a portable and non-invasive technique that can measure the ocular dimensions easily. Several studies have used A-scan, most comparing dimensions between PACG and control eyes. The purpose of this study is to compare the differences in Ocular Biometric measurements among different stages of PACG, including 1) Primary angle-closure suspect, 2) Primary angle closure, and 3) Primary angle-closure glaucoma.

AIMS AND OBJECTIVES

The aims and objectives of this study are to compare the biometric findings like

1. Anterior Chamber Depth
2. Lens Thickness
3. Axial length
4. Lens Axial Factor, i.e., LT/AXL x 10 (Relative lens thickness)
5. Relative Lens Position i.e (ACD+0.5LT)/AL x10 (lowe's formula)
6. Corneal diameter
7. Mean Keratometry In primary angle-closure suspect, Primary angle closure,and primary angle-closure glaucoma.

MATERIALS AND METHODS

This is a crossectional and comparative study. This study was conducted on patients presented to the outpatient department of the Regional Eye Hospital of a tertiary care hospital. Ethical approval for this study was obtained from the ethics review board of the hospital.

SELECTION OF CASE

A total of 111 eyes involving the age of above 40 years and both sexes with open angles, PAC, PACG, and PACS with a clear lens were selected according to the exclusion and inclusion criteria. As discussed in the investigations below, these eyes underwent an ocular evaluation in the present study from November 2018 to October 2020.

CONTROL GROUP

Subjects with a normal ocular examination and intraocular pressure less than 21 mm Hg, open-angle on gonioscopy, no lenticular opacity, and no history ofintraocular surgery were included in the normal group (control).

INCLUSION CRITERIA

Subjects above the age of 40 with a clear lens, and patients with a shallow anterior chamber were selected.

EXCLUSION CRITERIA

- Subjects were having a history of previously diagnosed glaucoma
- Previous history of intraocular surgery, laser iridotomy, or refractive surgery
- Use of antiglaucoma medication
- Evidence of active keratitis
- Anterior segment pathology precluding examination
- Uncooperative patients

The eyes that satisfied the eligibility criteria were included in the study. If both eyes of the subject were eligible, both eyes were selected for analysis. Similarly, in cases with bilateral ACG or occludable angles, both eyes were selected for analysis. Ocular biometry data in PACS, PAC, and PACG were compared with a subset of normal open-angle subjects.

EVALUATION: Patients subjected to complete ocular evaluation, including detailed history taking.

- Visual acuity recording
- Anterior Chamber Depth by Slit lamp(Von Herrick Grading)
- Goldmann applanation Tonometry

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A-scan Biometry

Cases classified as PACS, PAC, and PACG and the randomly selected normal underwent ocular Biometry. A random subgroup of the normal subjects, chosen by systematic random sampling, also underwent Biometry. Biometry was performed after anterior segment examination, and gonioscopy was completed. The ocular surface was anesthetized with 0.5% proparacaine hydrochloride (Propcaine, Cipla) eye drops, and Biometry was performed using the Axis Nano A-scan biometer (Quantel medical). The AXL, ACD, and the LT were measured for each eye. Biometry was performed over all subjects before the use of any mydriatics or pilocarpine. Lowe's formula[52], which is the sum of the anterior chamber depth +half lens thickness divided by axial length used to determine the relative lens position(RLP).Lens/axial length factor (LAF) by using the formula LT/AXLx10.

A SCAN- PROCEDURE

1. Anaesthetise the cornea using0.5% proparacaine hydrochloride eye drops
2. The probe lightly touches in such a way that the barrel of the probe is aligned with the optical axis or visual axis of eye
3. The probe aims towards the macula
4. Alignment of the optical axis will be indicated by high lens spikes and highretina spikes on the scan graph.

Statistical analysis

Data was entered into the Microsoft Excel datasheet and was analyzed using SPSS 22 version software. Categorical data was represented in the form of Frequencies and proportions. A **Chi-square test** was used as a test of significance for qualitative data. Continuous data were represented as mean and standard deviation. **ANOVA test** was used as a test of significance to identify the mean difference between two or more quantitative variables and qualitative variables, respectively.

OBSERVATION AND RESULTS

Table 1: Age Distribution between four groups

		Group							
		Open-angle		PACS		PAC		PACG	
		Count	%	Count	%	Count	%	Count	%
Age Group	< 50 Years	28	96.55%	24	60.00%	8	66.67%	28	93.33%
	> 50 Years	1	3.45%	16	40.00%	4	33.33%	2	6.67%

In Open Angle Group, 96.55% were < 50 Years and 3.45% were > 50 Years, In PACS Group 60.00% were < 50 Years and 40.00% were > 50 Years, In PAC Group 66.67% were < 50 Years and 33.33% were > 50 Years and In PACG Group 93.33% were < 50 Years and 6.67% were > 50 Years.There was a significant difference in Age Distribution between the four groups.

Table 2: Mean Age Comparison between four groups

	Group								
	Open-angle		PACS		PAC		PACG		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	p-value
Age	45.55	2.77	50.60	4.67	48.33	3.96	45.03	3.19	< 0.001*

Mean Age in Open-Angle Group was 45.55 ± 2.77, In PACS was 50.6 ± 4.67, In PAC was 48.33 ± 3.96, and In PACG was 45.03 ± 3.19.

There was a significant difference in Mean Age Comparison between the fourgroups.

Table 3: Gender distribution

Gender	Number	%
Male	40	36.04
Female	71	63.96
Total	111	100.0

Table 4: Gender distribution between four groups

	Group							
	Open-angle		PACS		PAC		PACG	
	Count	%	Count	%	Count	%	Count	%

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Sex	Female	14	48.28%	24	60.00%	9	75.00%	24	80.00%
	Male	15	51.72%	16	40.00%	3	25.00%	6	20.00%

In Open Angle Group, 48.28% were female, and 51.72% were Male, In PACS Group, 60.00% were female, and 40.00% were Male,
In the PAC Group, 75% were female, and 25% were Male andIn PACG Group, 80% were female, and 20% were male. There was no significant difference in Sex Distribution between the four groups.

Table 5: Mean Axial length Comparison between four groups

	Group								
	Open-angle		**PACS**		**PAC**		**PACG**		
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**p-value**
AXL	23.18	.62	22.17	.27	22.34	.11	22.15	.20	< 0.001*

Mean AXL in Open-Angle Group was 23.18 ± 0.62, In PACS was 22.17 ± 0.27, In PAC was 22.34 ± 0.11, and In PACG was 22.15 ± 0.2. There was a significant difference in Mean AXL Comparison between the four groups. There is a significant difference in Axial length between the Controls and the PACS group.

Table 6: Comparison of Mean Axial length in Males and Females

GROUP	**MEAN AXIAL LENGTH**		**P- VALUE**
	MALE	**FEMALE**	
OPEN ANGLE	23.30	23.05	<0.0001
PACS	22.27	22.10	<0.0001
PAC	22.32	22.33	0.8432
PACG	22.32	22.10	0.122

There was a significant difference in mean AXL in males and females of the Openand PACS groups.

Table 7: Mean Lens Thickness Comparison between four groups

	Group								
	Open-angle		**PACS**		**PAC**		**PACG**		
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	p-value
LT	4.30	.25	4.54	.25	4.38	.16	4.49	.25	0.001*

Mean LT in Open-Angle Group was 4.3 ± 0.25, In PACS was 4.54 ± 0.25, In PAC was 4.38 ± 0.16, and In PACG was 4.49 ± 0.25. There was a significant difference in Mean LT Comparison between the four groups.

Table 8:Comparison of Mean Lens thickness in Males and Females

GROUP	**MEAN LT**		**P- VALUE**
	MALE	**FEMALE**	
OPEN ANGLE	4.172	4.43	0.0020
PACS	4.815	4.35	<0.0001
PAC	4.29	4.41	0.2650
PACG	4.7	4.44	0.1675

There was a significant difference in mean AXL in males and females of theOpen and PACS groups.

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Table 9: Mean Anterior Chamber Depth Comparison between four groups

	Group								
	Open-angle		PACS		PAC		PACG		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	p-value
ACD	3.04	.40	2.38	.15	2.38	.14	2.41	.18	< 0.001*

Mean ACD in Open-Angle Group was 3.04 ± 0.4, In PACS was 2.38 ± 0.15, In PAC was 2.38 ± 0.14, and In PACG was 2.41 ± 0.18.

There was a significant difference in Mean ACD Comparison between thefour groups.

Table 10: Comparison of Mean Anterior Chamber Depth in Males and Females

GROUP	MEAN ACD		P- VALUE
	MALE	FEMALE	
OPEN ANGLE	3.13	2.93	0.1811
PACS	2.36	2.38	0.7873
PAC	2.28	2.41	0.1655
PACG	2.65	2.34	0.00001

There was a significant difference in Anterior chamber depth between malesand females of the PACG group.

Table 11: Mean Lens Axial Factor Comparison between four groups

	Group								
	Open-angle		PACS		PAC		PACG		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	p-value
LAF	1.80	.33	2.04	.11	1.96	.07	2.03	.10	< 0.001*

Mean LAF in Open-Angle Group was 1.8 ± 0.33, In PACS was 2.04 ± 0.11, In PAC was 1.96 ± 0.07, and In PACG was 2.03 ± 0.1.

There was a significant difference in Mean LAF Comparison between the fourgroups.

Table 12: Comparison of Mean Lens axial factor in Males and Females

GROUP	MEAN LAF		P- VALUE
	MALE	FEMALE	
OPEN ANGLE	1.683	1.92	0.048
PACS	2.16	1.96	<0.00001
PAC	1.92	1.97	0.207
PACG	2.104	2.011	0.042

There was a significant difference in Mean LAF in males and females of theopen-angle, PACS, PACG group.

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Table 13: Mean Relative Lens Position Comparison between four groups

	Group								
	Open-angle		PACS		PAC		PACG		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	p-value
RLP	2.23	.13	2.10	.07	2.05	.08	2.10	.11	< 0.001*

Mean RLP in Open-Angle Group was 2.23 ± 0.13, In PACS was 2.1 ± 0.07, In PAC was 2.05 ± 0.08, and In PACG was 2.1 ± 0.11.
There was a significant difference in Mean RLP Comparison between the fourgroups.

Table 14: Comparison of mean Relative lens position in males and females

GROUP	MEAN RLP		P- VALUE
	MALE	FEMALE	
OPEN ANGLE	2.24	2.22	0.756
PACS	2.14	2.06	0.0003
PAC	1.98	2.06	0.0969
PACG	2.24	2.06	0.0001

There was a significant difference in RLP between males and females in PACS andPACG groups.

Table 15: Mean Corneal Diameter Comparison between four groups

	Group								p-value
	Open-angle		PACS		PAC		PACG		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
CD	11.54	.11	11.25	.06	11.40	.05	11.40	.10	< 0.001*

Mean CD in Open-Angle Group was 11.54 ± 0.11, In PACS was 11.25 ± 0.06, In PAC was 11.4 ± 0.05, and In PACG was 11.4 ± 0.1.
There was a significant difference in Mean CD Comparison between the four groups.

Table 16: Comparison of Mean Corneal Diameter in Males and Females

GROUP	MEAN CD		P- VALUE
	MALE	FEMALE	
OPEN ANGLE	11.56	11.52	0.3370
PACS	11.22	11.26	0.046
PAC	11.38	11.40	0.4611

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PACG	11.46	11.38	0.1136

Table 17: Mean Keratometry Comparison between four groups

	Group								
	Open-angle		PACS		PAC		PACG		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	p-value
Mean K	45.08	.04	45.24	.03	45.38	.37	45.46	.08	0.001*

Mean K in Open-Angle Group was 45.08 ± 0.04, In PACS was 45.24 ± 0.03, In PAC was 45.38 ± 0.37, and In PACG was 45.46 ± 0.08.
There was a significant difference in Mean K Comparison between the four groups.

Table 18: Comparison of Mean Keratometry in Males and Females

GROUP	MEAN K		P- VALUE
	MALE	FEMALE	
OPEN ANGLE	45.06	45.1	0.0115
PACS	45.24	45.23	0.7335
PAC	45.09	45.47	0.1337
PACG	45.48	45.45	0.3929

There was a significant difference in mean keratometry in males and females of theOpen-angle group**.**

DISCUSSION

The most apparent characteristic of the eye with, or predisposed to, angle- closure glaucoma is a markedly shallow anterior chamber. That is closely related to the dangerously narrow or closed-angle, and it results from a summation of lesser anatomical differences:

I. (a) Presence of a thicker crystalline lens, which increases as age progress.

(b) A more anterior position of the lens, and therefore pupil, than IV below canexplain,
and which increases as lens diameter increases to loosen suspensory ligament. These result in iris elevation and hence iris bombe.

II. Corneal abnormalities

(a) Smaller corneal diameter, producing
(b) Lower corneal height
(c) Steeper corneal curvature.

III. Asymmetry of the angle. The angle is narrower superiorly so that this area tends to close first as the axial thickness of the lens increases with increasing age. The slow evolution of closure explains the common causes of chronic closed-angle glaucoma (due to permanent goniosynechiae) and the rare case of chronic angle- closure glaucoma (due to iridotrabecular contact): it may well also account for reversible subacute attacks.

IV. Shorter axial length of the scleral envelope, implying smaller over-all dimensions except, of course, for lens thickness (and thickness of the wall).In individual cases of angle-closure glaucoma, each of the above may contribute to different amounts- especially, there may be reciprocity between I and II. The common inherited determinant of all these properties is probably the small eyeball

V.Biometry during ocular development

Ocular Biometry changes dramatically in the first years of life. The neonatal eye's anterior segment is about 75% to 80% of an adult eye's size, while the posterior segment of the eye is more than 50% smaller than an adult [7]. The Axial Length at birth is approximately 16 mm [7], after which it continues to grow until it reaches the adult length by 13 years of age [8]. There is a rapid growth phase in the first 18 months, adding 4.3mm to the Axial Length. From 2 to 5 years, it increases by 1.1 mm, followed by the final, slower juvenile stage from the age of 5 to 13 years; during that time, it grows an

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additional 1.3 mm [9]. In an adult, the Axial length is approximately 23.6 mm [9,10], the ACD is about 3.24 mm [9,] and the LT is about 4.63 mm57. The Anterior chamber depth decreases, and the lens's thickness increases with increasing age, although these changes appear to reverse in the seventh decade and beyond [10].

Biometric Characteristics of PACG

Compared with normal eyes, eyes with PACG have a shallower anterior chamber, a thicker lens, a more anterior lens position, and a shorter ocular AL [11]. The Anterior Chamber Depth of eyes with PACG is less than 3.0mm (2.29-2.77 mm), about 0.5 to 1.0 mm shallower' than normal eyes (2.81-3.33 mm) [12].

The Lens Thickness in PACG is usually greater than 5.0 mm (range, 4.73-5.43 mm), and that of normal eyes is about 4.5 mm (range, 4.3-4.73 mm), which is a difference of about 0.3 to 1.0 mm [14]. The Axial Length in PACG (range, 22.01-22.48 mm) is approximately 1.0 mm less than normal eyes (range, 23.16–23.38mm) [12].

As a result, eyes with Primary Angle Closure Glaucoma usually have a relatively thicker lens (lens/axial length factor [LAF] = [LT/AL] × 10) than normal eyes. Also, the lens in PACG is situated more anteriorly than in normal eyes [13]. All of these factors lead to the development of angle-closure and, eventually, glaucoma.

The anterior chamber depth depends on the position of the anterior lens surface, and it is determined by the thickness and the lens position inside the eye. Lowe compared Australians with angle-closure to normal patients and concluded that 66% of the difference was attributable to the anteriorly positioned lens and 33% to a thicker lens [(14)]. In Chinese patients, Friedman *et al*. found that Lens Thickness was the major contributor to a shallow anterior chamber. Regardless of the precise anatomic factors in any particular eye, a shallow Anterior Chamber Depth is considered the essential biometric feature indicating a risk for angle closure.

The present study aims to detect the significance of AXL, LT, ACD, LAF, RLP, Corneal diameter, Mean keratometry among eyes with open angles, PACS, PAC, and PACG in eyes with clear lens. Based on clinical examination, A-scan biometryfindings, the patients were divided into

Group 1: OPEN ANGLES
Group 2: PRIMARY ANGLE CLOSURE SUSPECTGroup 3: PRIMARY ANGLE CLOSURE
Group 4: PRIMARY ANGLE CLOSURE GLAUCOMA

GROUP 1: OPEN ANGLES (CONTROL GROUP)

There were 29 eyes in this group: The mean age group was 45.55±2.77, Mean axial length was 23.18±0.62, Mean LT was4.3±0.25, Mean ACD was 3.04±0.4, mean LAF was 1.8±0.33, Mean RLP was 2.23±0.13Mean, the CD was 11.54±0.11, Mean keratometry was 45.08±0.04.

GROUP 2: PRIMARY ANGLE CLOSURE SUSPECT

There were 40 eyes in this group, and The mean age group was 50.6±4.67. Mean axial length was 22.17±0.27, Mean LT was4.54±0.25, Mean ACD was 2.38±0.15, mean LAF was 2.04±0.11, Mean RLP was 2.1±0.07, Mean CD was 11.25±0.06, Mean keratometry was 45.24±0.03.

GROUP 3: PRIMARY ANGLE CLOSURE

There were 12 eyes in this group, and The mean age group was 48.33±3.96. Mean axial length was 22.34±0.11, Mean LT was4.38±0.16, Mean ACD was 2.38±0.14, mean LAF was 1.96±0.07, Mean RLP was 2.05±0.08Mean CD was 11.4±0.05, Mean keratometry was 45.38±0.37.

GROUP 4: PRIMARY ANGLE CLOSURE GLAUCOMA

There were 30 eyes in this group, and The mean age group was 45.03±3.19. Mean axial length was 22.15±0.2, Mean LT was4.49±0.25, Mean ACD was 2.41±0.18, mean LAF was 2.03±0.1, Mean RLP was 2.1±0.11Mean CD was 11.4±0.1, Mean keratometry was 45.46±0.08.

George *et al*.[15] have done a population-based study. A total of 2850 subjects were examined, and 143 were diagnosed to have occludable angles, and 22 were angle-closure glaucoma, and the control group comprised 419 randomly selected normal subjects.

The mean age in Controls of the present study is 45.55, which is less than the other studies, Tomsilon A *et al*. [16](64.48),

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y.y Chen *et al.* [18](62.7)' Ramakrishna Swathi *et al.* [17](49.95), George *et al.* [8](49.95).

The mean age in the PACS group is 50.6, which is less as compared to Ramakrishna Swathi *et al.*[17](52.35), George *et al.* [15](54.4),' The mean age in PAC is 48.33, which is less than Y.Y Chen *et al.* [(18)](65.3).

The mean age in PACG is 45.03, which is less compared to Ramakrishna Swathi *et al.*[17](62.52), George *et al.* [15](57.45).

The mean age is less than other studies because only subjects with a clear lens were included in the present study, whereas the remaining studies had the cataractous lens. There was a significant difference in mean age between the four groups(p=<0.001).

All the above-mentioned studies' including our study, show that PACG is commoner in females than males, as females have shorter eyes, shallower AC, and thicker lenses. There were a significantly larger percentage of females in PACS (40% Male: 60%Female), PAC (25% Male:75% Female), PACG (20%Male:80%Female) groups compared to normal group(52%Male:48%Female).

There was no significant difference (p=0.062) in sex distribution between the four groups, similar to the study by Y.Y Chen et a[18](p=0.09) .

The mean axial length in Controls is 23.18+0.62, which is more in the study done by Y.Y Chen *et al.*[18] (23.76+1.01) and less in studies Tomsilon A(23.13), [16] Ramakrishna Swati *et al.* (23.26), [17] and George *et al.* (22.76). [15]

The mean ACD in the Controls of the present study is 3.04±0.4, which is less compared to the Mean ACD in Ramakrishna Swati *et al.* (3.19), [17] Y.Y Chen *et al.* (3.11+0.29), [18] and ACD is less in George *et al.* (3.00). [15]

The Mean ACD in PACS is 2.38± 0.15 in the present study, and it is less compared to studies done by Ramakrishna Swati *et al.* (2.74), [17] George *et al.* (2.53), [15] and in Tomsilon A(3.17). [16]

The crystalline lens is larger in its anteroposterior axis in angle-closure glaucoma than in normal with advancing age—the lens increases in size, which causes further shallowness of the anterior chamber. When a critical amount of anterior chamber shallowing occurred, iris bombe leads to angle-closure.

The Mean LT in controls of the present study is 4.3±0.25, which is more compared to the controls of Ramakrishna Swati *et al.* (3.96), [17] and less compared to the controls of George *et al.* (4.31) [15] and Y.Y Chen *et al.* (4.53±0.43). [18]

Lens axial factor is defined as the ratio between lens thickness and axial length as a representative and unifying unit for biometric assessment of the eye. This factor determines the relationship between the lens, iris, and cornea and, thus, the angle status. Lens axial factor values were found to be age-dependent and greater than normal for most age groups, with angle-closure glaucoma LAF represent the lens's relative size. In our study, the mean LAF in controls is 1.88±0.33, which is more compared to controls of Ramakrishna Swati *et al.* (1.77) [17] and less compared to George *et al.* (1.92) [15] and Y.Y Chen *et al.* (1.91±0.20). [18]

RELATIVE LENS POSITION

Relative lens position has been considered to be an essential determinant in primary angle closure glaucoma. It was calculated by using Lowe's formula (ACD=0.5LT)/ALx10.

Simple measurement of ACD is not sufficient to assess appositional angle closure in narrow angles. RLP might be an essential factor in appositional angle closure.

The Mean RLP in the present study control group was 2.13±0.13, which is less than the control group of Ramakrishna Swathi *et al.* 1[7] (2.23), Y.Y Chen *et al.* [18] (2.26±0.13) studies controls mentioned above.

Most of the studies mentioned above not included the corneal curvature except the study done by Razeghinejad *et al.* (19).

The mean keratometry in this study's PACS group is 45.24±0.04, which is more than the PACS group of Razeghinejad *et al.* (45.01±1.72). [19]

The mean keratometry in this study's PACG group was 45.46±0.08, which is more than the PACG group of Razeghinejad *et al.* [19] There is a significant difference in mean keratometry between the four groups in this study. There is no significant difference in mean keratometry between PACG and PACS.

CORNEAL DIAMETER

Various studies mentioned above not included the corneal diameter. In this study, the Mean CD in open-angle was

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11.54± 0.11, in PACS 11.25±0.06, In PAC was 11.4±0.05, In PACG 11.4±0.1 The present study showed significant difference($p<0.001$) in mean corneal diameter between the four groups, and there is a progressive decrease in corneal diameter in PACG compared to controls.

There is evidence in the literature that eyes with angle-closure glaucoma and PACS have shorter axial lengths, shallower anterior chamber depths, and thicker crystalline lenses.[20]

CONCLUSION

This Present study compared the ocular biometric characteristics in the PACS, PAC, and PACG with the open-angle group.

- The Axial length, Anterior chamber depth was more in males than the females in the PACS & Open Angle group, and no difference was noted in other groups.
- In this study, PACS eyes were associated with short axial length, shallow anterior chamber, thick crystalline lens, anteriorly placed lens, small corneal diameter, and steep corneal curvature than the eyes of the open-angle group.
- PAC eyes were associated with shallow anterior chambers, thick crystalline lens, anteriorly placed lens, small corneal diameter, steep corneal curvature compared to the open-angle group.
- PACG eyes were associated with short axial length, shallow anterior chambers, thick crystalline lens, anteriorly placed lens, small cornealdiameter, steep corneal curvature compared to the eyes of the open-angle group.
- The Analysis of Ocular biometric values is a simple, readily available, and useful test employed in PACS, PAC, and PACG.

Acknowledgement

The author is thankful to Department of Ophthalmology for providing all the facilities to carry out this work.

Conflict of Interest None

Funding Support Nil

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